A digest of current natural science issues in King County Article 1002-2 February 2010

Climate Change Impacts on River Flooding: State-of-the-Science and Evidence of Local Impacts

By Curtis DeGasperi

A report under development summarizes current scientific evidence for climate change related trends in river flooding and evaluates historical King County river flow data to identify flow trends. Specifically, trends related to magnitude, duration, frequency, and timing of high river flow. Part of the overall work program includes evaluation of river flow hydrologic simulation results (using output at the same gaging locations) for potential future trends using downscaled global climate model runs.

The chart on the next page illustrates preliminary results of three different climate model scenarios for the same reach of the Snoqualmie River. The model runs forecast return interval flows for years 2000, 2025, 2050 and 2075.

This report will provide an assessment of potential changes in future river flows in response to climate change. The implications for flood management in King County will be more fully discussed based on the review of the scientific evidence for climate-related changes in river flooding, historical trend analysis results, and predicted future river conditions.

Background

Flooding is arguably the most costly natural hazard in King County. Since 1978, King County has had the most flood insurance claims and the greatest number of repetitive flood loss properties of any county in the State of Washington (Washington State Hazard Mitigation Plan, November 2007).

Growing flood damage costs are primarily due to the intersection of naturally powerful and dynamic river floodplain interactions, and the concentration and continuing encroachment of people and their infrastructure in floodplains. However, there is mounting evidence that stream-flow has generally been increasing in the United States since the 1940s, although the Pacific Northwest was noted as having a number of stream-flow decreases, particularly in the lowest flow percentiles.

Preliminary Findings

Findings to-date indicate what seems to be some seasonality to these stream-flow trends, with the flow increases detected mostly in October and November. This appears to be consistent with observed seasonality in increases in precipitation in the U.S.

Because King County is in the path of warm, moist air flow coming from the Pacific Ocean bumping up against the windward side of the Cascade Mountains and other areas along the Pacific Coast, this area experiences some of the highest relative flow magnitudes in the conterminous United States and Alaska.

Generally, the magnitude of King County floods depends on a number of factors including:

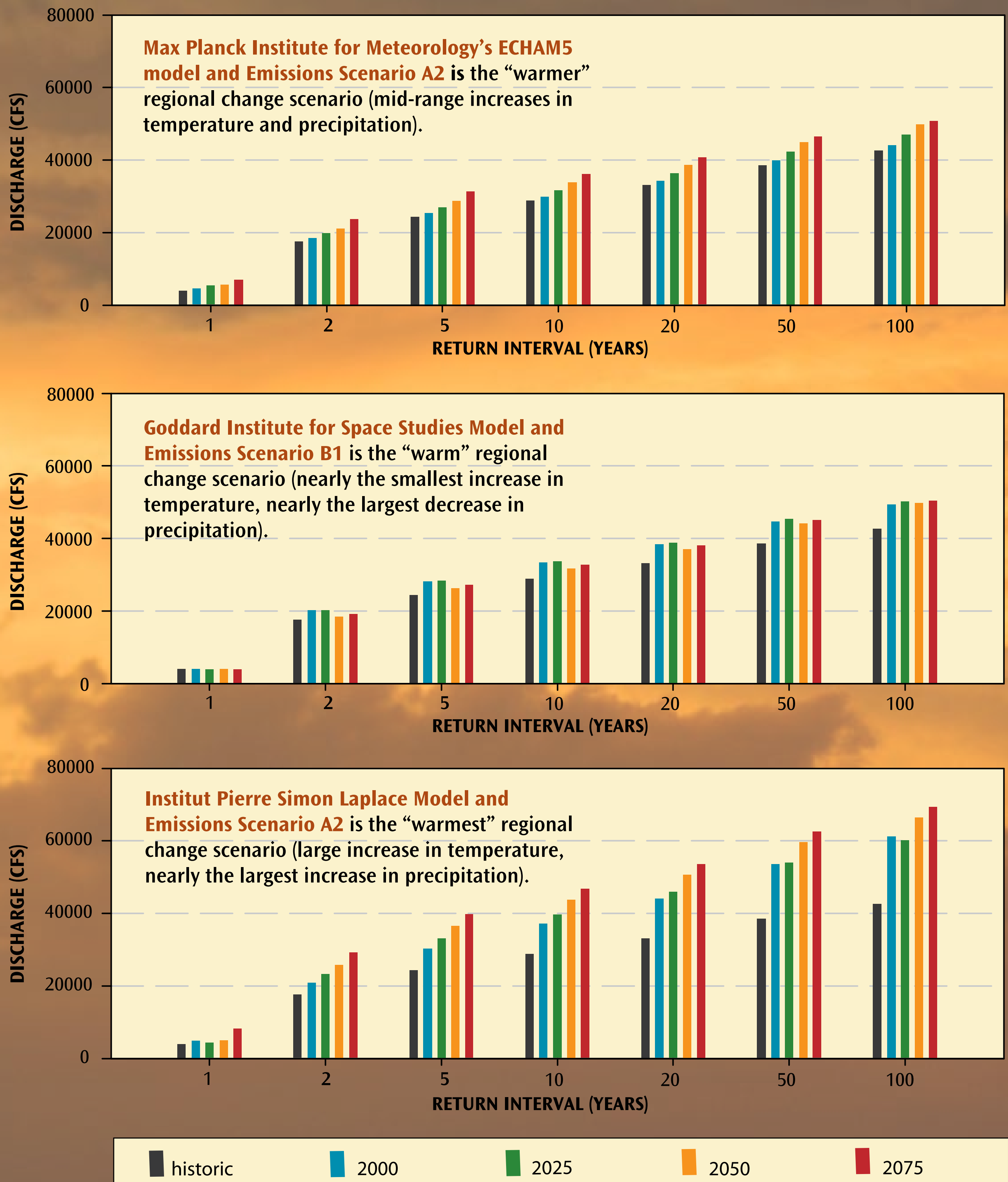
- Intensity and duration of rainfall;
- Antecedent soil moisture conditions;
- Basin area and elevations; and
- Snow pack presence, location and depth.

Some of the largest recorded floods in the Pacific Northwest, including the floods of 1964 and 1996, were cased by substantial rain-on-snow events, which most significantly affect larger drainage basins on the order of 100 to 100,000 square miles.

Preliminary analyses suggest an increase in the magnitude, duration, frequency and timing of extreme precipitation and river flow. This appears to be the result of some combination of decadal variation in precipitation and climate change-related upward shifts in temperature and snow accumulation and melt.

It should be noted that the detection of these trends is difficult; not only because of the relative infrequent nature of extreme events and the limited number of stations and record lengths evaluated, but difficult because of changes in land cover that have occurred over the period of analysis, which is primarily forest harvest and re-growth.

Projected return interval flows for Snoqualmie River near Snoqualmie (USGS 12144500) based on output using downscaled climate predictions from three Global Climate Model Scenarios representing current and future periods centered on years 2000, 2025, 2050, 2075. Return interval flows calculated from historic and future climate hydrologic model output provided by Austin Polebitski and Richard Palmer as part of the work conducted for Regional Water Supply Planning Climate Change Technical Subcommittee (www.govlink.org/regional-water-planning/)



Flood Management and Associated Preliminary Finding

Historically, flood management has been based on the use of historical data to estimate flood return probabilities of specific magnitudes e.g. 50-year, 100-year flood returns. However, trends in observed data and modeling of potential future conditions suggest that this approach (based on the assumption of stationarity*) is no longer valid. It should be noted that there is no other approach to this type of analysis that has reached the level of what might be considered a consistent standard practice that would be suitable for a nationwide flood management program such as the Federal Emergency Management Agency (FEMA).

The issue of stationarity and the potential of a future hydrologic regime with ever-greater frequency and magnitude of high flows suggest that a more integrated water management approach would be beneficial (Green, 2004; Meyer et al., 2009).

For those who would like to be notified when the final report becomes available, please contact Curtis DeGasperi at Curtis.DeGasperi@kingcounty.gov

*A stationary time series is one whose statistical properties such as mean and variance are constant over time. Standard flood frequency analysis assumes that annual maximum flow series are stationary. However, land cover change, hydrologic modification via dams and flood plain alteration, and climate change bring the assumption of stationarity into question (Milly et al. 2008).

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Section Manager: Randy Shuman

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Contributors and Photographers: Jeff Burkey, Terry Butler, Curtis Degasperi, Kyle Comanor, P.E., Larry Jones and Ray Timm

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Send questions, comments and future story ideas to:
Kate O'Laughlin - kate.olaughlin@kingcounty.gov, 206-296-8363 or
Jim Simmonds - jim.simmonds@kingcounty.gov, 206-296-1986